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ABSTRACT

Results of a preliminary study that examined various factors relating to achievement in introductory level biology, chemistry, and physics classes at a public junior college are presented. Background variables, including age, sex, college major, grade point average, SAT-Verbal and SAT-Quantitative, and the sixteen-part scores of Academic Motivations Inventory (Form D) were examined as possible predictors of academic achievement. Conclusions are made which include a discussion of the finding that portions of the Academic Motivations Inventory can be useful predictors of academic achievement when coupled with other factors such as grade point average or SAT scores. (CS)

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A Study of Motivation and Other Factors as Relating to Course Achievement in Introductory College Biology, Chemistry, and Physics

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Multitudes of studies have reported on factors relating to achievement in introductory level college science courses. These studies have occurred across all subject lines and within every type of institution from public universities down through private junior colleges. This paper presents one such study in biology, chemistry, and physics conducted at a public junior college. It differs from many previous studies by attempting to examine academic motivations as possible variables of significant correlation to course grade.

Background factors such as high school science and mathematics background, high school grade point average, and college background information are not included in the current study. Information such as age, sex and college major is readily available and was used.

In biology courses Chesson (1975) reported significant correlation between standardized test such as ACT or SAT and course grade, while others such as Spencer (1975) reported no such correlation could be found. In introductory chemistry studies, Hendricks (1962) reported significance in correlation between SAT scores and course grade while Naibert (1964) and Longmire (1973) did not find it significant.

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In physics classes Blumenthal (1961), Fulwood (1966), Demas (1977), and Pridmore (1979) found ACT or SAT scores to be useful predictors. Age or sex, or both, were reported significant predictors in studies by Foster (1938), Whitten (1968), and others.

The authors of the current study acknowledge the valuable results of many other studies and the fact that those cited are but only a few random examples. Time constraints limit the scope of the literature review.

The study reported today used age, sex, college major (science, non-science), grade point average, SAT-Verbal, SAT-Quantitative, and the sixteen part scores of Academic Motivations Inventory, Form D (Doyle and Moen, 1978) as predictors of academic achievement as measured by course grades for students taking either biology, chemistry, or physics at a public junior college in a metropolitan area. The study took place during 1980.

The Academic Motivations Inventory measures are listed in Table I. In correspondence with the authors of this study, Moen and Doyle (1980) gave brief descriptors to the various motivations. Ones occurring as significant in this study have the following descriptors:

Achieving Motives. Desiring to work hard and do one's best.

Debilitating Anxiety. Pressure, anxiety, or the possibility of failure are painful and interfere with doing good work.

Demanding. Refusing to passively accept disliked teaching practices.

Influencing Motives. Enjoying arguing with others or being a leader.

Dislike School. Disliking school, lacking interest, preferring other activities.

Discouraged about School. Feeling that school is too hard or that it does little good to study.

Data relevant to factor analysis, reliability, and validity of the instrument are available in the literature (Doyle and Moen, 1978).

Stepwise multiple regression analysis was performed by means of the BMD-02R program (Dixon, 1970) for each of the subject disciplines. Data were gathered for 140 students in biology, 63 in chemistry, and 51 in physics.

Table II gives the statistical background information as to age (years, actual) at the completion of the course, sex (0-male, 1-female), college major (0-non science, 1-science), SAT-Verbal and SAT-Quantitative scores (800 points maximum,each) for the students in each science area.

As would be expected, the three groups differ greatly as does the nature of the courses within which the students enrolled. The biology course is the traditional college biology sequence for both science and non-science majors. The chemistry course is intended for non-science majors and as remediation for science majors without a background in high school chemistry. The physics section is open to all but is taken by science and pre-professional majors with a good mathematics background. It is not for physics, chemistry, or pre-engineering students.

The study was separated into two parts as a practical matter. One part was done using college grade point average. In the other part, grade point average was not analyzed as a factor due to the small number of quarter credit hours earned by the students at the conclusion of the study. Most were beginning

freshmen. Since the college grade point average reported was at the conclusion of the course in question, beginning freshmen would naturally have somewhat artifically high correlations between course grades and college grade point average.

Table III gives a listing of factors from the correlation matrix whose semi partial correlation coefficients with course grade were found to be significant. Given the method of reporting the college grade point average, it should come as no surprise that all three disciplines had significant correlations with grade point average.

Biology and chemistry correlations were similar in factors from the Academic Motivations Inventory as well as SAT Quantitative scores. The physics correlations must, however, be viewed with reservations due to the small number of students. In light of previous research one with predicting achievement in physics at the same institution with a larger sample size (N=168) it was expected that SAT scores might be significant. With the current small sample (and smaller than expected standard deviation of SAT-Q scores) not enough variation was present to provide a significant trend.

Biology Studies

Using multiple regression analysis on the biology sample (N=140) and including grade point average, the regression equation contained: grade point average (F to remove = 180.03), achieving motives (F = 5.12), and discouraged about school (F = 4.22). The equation had a multiple R value of 0.8259 accounting for 68.2% of the variance in the course grade. The equation's F-ratio was 97.31 with a standard error of the grade estimate of 0.6873 on a zero to four scale. (See Table IV.)

Achieving motives showed a positive correlation to course grade as would seem appropriate. Students who express a willingness to work hard and are proud of their work usually are among the better students. The discouraged about school motive had a negative correlation. Those who felt school was too hard or thought studying did not accomplish anything did not do as well as those who saw the benefit of studying.

Without the college grade point average (N=124) the factors involved in the regression equation were: SAT-Q (F to remove = 45.45), achieving motives (F = 16.80), competing motives (F = 5.94), and dislikes school (F = 8.94). The equation had a F-ratio of 24.18 and accounted for 44.8% of the variance while yielding a standard error of estimate of 0.8897. (See Table V.)

The competing motives shows a negative correlation coefficient. Apparently, as is shown by this and other local studies with the same results, students at the junior college in question have fewer tendencies toward trying to do better than others and so would not be apt to do as well in situations as might be found in large universities where competion is keenest. Not of such a surprise is the negative correlation between disliking school and course grade. If the students express a preference for other activities they are apt not to spend an appropriate amount of time studying.

Chemistry Studies

In the chemistry study using grade point average (N=63) only the grade point average (F = 82.51) and discouraged about school (F = 6.44) were significant beyond the .05 level. The regression equation had a multiple R value of 0.7838 accounting for 61.4% of the variance with a standard error of estimate of 0.7925. The equation's F-ratio was 47.8 with 2 and 60 degrees of freedom. (See Table VI.)

Using SAT instead of the grade point average (N=52), the factors of SAT-Q (F =8.93), achieving motives (F = 21.55), and grades orientation were significant beyond the .05 level. Forty-six percent of the variance was accounted for in the course grade with a standard error of estimate of 0.9473. The equation's F-ratio was 13.17 with 3 and 48 degrees of freedom. (See Table VII.)

Physics Studies

Physics differed from the other two subject areas as to the number of quarter hours of credit completed by the students. The mean number was 40.05. Using the grade point average (N=51) the regression equation contained grade point average (F = 9.50), demanding motives (F = 11.89), and withdrawing motives (F = 4.81). The equation accounted for 41.2% of the variance. The equation's F-ratio was 10.98 with a standard error of estimate of 0.9545. (See Table VIII.)

The demanding motive showed a negative correlation coefficient with course grade. Introductory physics does not seem to lend itself to student freedom to decide acceptable learning modes. The students who seem to do best are those who readily adapt to the cognitive style of the instructor. Along the same lines, the positive correlation of withdrawing motives indicates preferring to work alone, finding group projects or class discussions unprofitable or unpleasant.

The factors of age, sex, and college major were not found to be significant in any of the subject areas.

Conclusions

According to the results of this preliminary study, it appears that portions of Academic Motivations Inventory, Form D can be useful predictors of academic

achievement when coupled with other factors such as grade point average or SAT scores. Those motives showing most are: achieving motives (a positive factor) and debilitating motives, dislikes school, discouraged about school, demanding motives, and influencing motives (all negative factors in this study).

Other background factors are highly likely to be correlated with course achievement and should be included when possible. Many of these factors such as high school science and mathematics background, high school grade point average, and other college background information are not readily available from computer records, requiring instead time consuming hand searches of private records. They were not selected for this study solely so the researchers could investigate the academic motivations.

Replication is highly desirable for the study, especially in light of the small sample sizes of the chemistry and physics groups.

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Table I

Sixteen Measurable Academic Motivations

THINKING MOTIVES	DEMANDING
PRESISTING MOTIVES	INFLUENCING MOTIVES
ACHIEVING MOTIVES	COMPETING MOTIVES
FACILITATING ANXIETY	APPROVAL MOTIVES
DEBILITATING ANXIETY	AFFILIATING MOTIVES
GRADES ORIENTATION	WITHDRAWING MOTIVES
ECONOMIC ORIENTATION	DISLIKE SCHOOL
DESIRE FOR SELF-IMPROVEMENT	DISCOURAGED ABOUT SCHOOL

Table II

Statistical Background of the Three Groups

	BIOLOGY		CHEMISTRY		PHYSICS	
	$\bar{X}$	S.D.	$\bar{X}$	S.D.	$\bar{X}$	S.D.
AGE	21,5	5.0	22.9	6.6	21.9	4.2
SEX	.607	.490	.683	.469	.216	.415
MAJOR	.207	.407	.540	.502	.608	.493
SAT-V	423.	85.	371.	88.	439.	89.
SAT-Q	426.	86.	383.	75.	513.	73.

Table III

Semi-partial Correlations from the Correlation Matrix

with Course Grade

BIOLOGY		CHEMISTRY		PHYSICS	
GPA	SAT	GPA	SAT	GPA	SAT
GPA	SAT V	GPA		GPA	
	SAT Q		SAT Q		
ACHIEV	ACHIEV	ACHIEV	ACHIEV		
DEBILI	DEBILI			DEBILI*	
DISLIK	DISLIK	DISLIK**	DISLIK*		
DISCOU	DISCOU	DISCOU**	DISCOU**	DISCOU	DISCOU
				DEMAND	DEMAND**
				INFLUE*	
df=138	df=122	df=61	df=50	df=49	df=42

$p < .01$ unless otherwise indicated

* $p < .02$

** $p < .05$

Table IV

Summary of Steps in Generating Regression Equation

Biology with Grade Point Average

Step Number	Variable Entered	Multiple R	Multiple R^2	Increase in R^2	F Value to Remove
1	COLGPA	.8148	.6638	.6638	180.03
2	ACHIEV	.8200	.6723	.0085	5.12
3	DISCOU	.8259	.6822	.0099	4.22

N=140

$F_{.05,1,120}=3.92$

Table V

Summary of Steps in Generating Regression Equation

Biology without Grade Point Average

Step Number	Variable Entered	Multiple R	Multiple R^2	Increase in R^2	F Value to Remove
1	SAT Q	.4875	.2377	.2377	45.45
2	DISLIK	.6047	.3657	.1280	8.49
3	ACHIEV	.6487	.4208	.0551	16.80
4	COMPET	.6696	.4483	.0275	5.94

N=124

$F_{.05,1,120}=3.92$

Table V

Summary of Steps in Generating Regression Equation

Chemistry with Grade Point Average

Step Number	Variable Entered	Multiple R	R^2	Increase in R^2	F Value to Remove
1	COLGPA	.7570	.5730	.5730	82.51
2	DISCOU	.7838	.6144	.0414	6.44

N=63

$F_{.05,1,60}=4.00$

Table VII

Summary of Steps in Generating Regression Equation

Chemistry without Grade Point Average

Step Number	Variable Entered	Multiple R	R^2	Increase in R^2	F Value to Remove
1	SAT Q	.4697	.2206	.2206	8.93
2	ACHIEV	.6185	.3826	.1620	31.55
3	GRADE 0	.6719	.4514	.0688	6.02

N=52

$F_{.05,1,40}=4.08$

Table VIII

Summary of Steps in Generating Regression Equation

Physics with Grade Point Average

Step Number	Variable Entered	Multiple R	Multiple R^2	Increase in R^2	F Value to Remove
1	COLGPA	.4844	.2347	.2347	9.50
2	DEMAND	.5932	.3519	.1172	11.89
3	WITHDR	.6419	.4121	.0602	4.81

N=52

$F_{.05,1,40}=4.08$